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ABSTRACT

This paper is an appraisal of the Colorado Elementary Science Project (CESP), a state-wide program to provide inservice education and assist school districts in the implementation of new elementary school science curricular programs. The University of Colorado and the Colorado State Department of Education cooperated in assisting school districts in their initial introduction of AAAS Science - A Process Approach, Elementary Science Study, and Science Curriculum Improvement Study. Selected elementary teachers were trained in the use of a new curricular program over a period of one school year while they were using the new materials with their own students. This was followed by a two-week summer session in which they were prepared to teach other teachers. Results of the evaluation indicate that: (1) one semester inservice course produced a change in the teacher's style of teaching science, (2) the major constraint limiting the full implementation of the new elementary science programs was the quantity of equipment and materials needed, and (3) principals became involved in implementation only if specific efforts were made to get them involved. (BR)

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EVALUATION OF THE
COLORADO ELEMENTARY SCIENCE PROJECT

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the National Association for Research in Science Teaching,
Minneapolis, Minnesota, March 7, 1970.

The evaluation reported herein is an appraisal of the Colorado Elementary Science Project (CESP)¹, as a statewide program to provide inservice education and assist school districts in the implementation of new elementary school science curricular programs. As such, this report is not research in the sense of providing generalized knowledge about human behavior. The information provided, however, is of more than local interest since it should be useful to persons attempting to provide large scale inservice education as a means of implementing curricular change.

The CESP was developed with the intent of assisting all school districts in the state of Colorado which desired assistance in their initial introduction of the ESS, SAPA, or SCIS² science programs. Since the personnel are limited almost entirely to members of the sponsoring agencies, the University of Colorado and the Colorado State Department of Education, the project must of necessity employ a multiplier principle to reach the large number of elementary teachers needing assistance. Selected elementary teachers are trained in

¹This project is now operating under the third year of NSF funding through the Cooperative College-School Science Program.

²ESS - Elementary Science Study, a program of the Education Department Center; SAPA - Science--A Process Approach, developed under sponsorship of the American Association for the Advancement of Science; and SCIS - Science Curriculum Improvement Study, a program developed by the organization of the same name.

the use of a new curricular program over a period of one school year while they are using the new materials with their own students. This is followed by a two week summer session in which they are prepared to teach other teachers. They then undertake almost the entire responsibility for teaching a three semester hour course which is a key part of implementing a new curricular program in a given school district.³

Participation in the project requires considerable local school district responsibility. Inservice classes are established only in districts where the necessary student equipment is provided, the initial selection of participants is done locally, and after the initial 16 months under CESP sponsorship, continued implementation of the new programs is a local district matter. The focus of the project is to aid school districts in beginning the implementation of new curricular programs, not simply to provide inservice education for teachers.

A major facet of the CESP involvement with a school district is the instruction of large numbers of teachers which is provided by the selected teachers who were trained during the preceeding year. This instruction is provided within the framework of a three semester hour course (undergraduate University credit) conducted

³Details of the program are given in Anderson, Ronald D., James Metzdorf, Glyn Sharpe, and Glenn McGlathery, "A Plan for the Implementation of New Elementary School Science Curriculum Programs in Colorado," University of Colorado, 1969. (mimeo)

weekly after regular school hours and visits by the instructor to the classrooms of the teachers taking the class. Extensive work by the teachers with the new materials and with groups of children using the materials are part of the course. The observation and analysis of teaching, both live and videotaped, are employed.

SELECTED QUESTIONS

That portion of the evaluation of the CESP reported herein is limited to the study of selected questions which are likely to be of interest to persons making decisions in the operation of similar types of programs. These questions are given below along with information that bears upon their answers within the CESP as presently operated. Because they were selected on the basis of their importance as well as the information available to answer them, there are several for which only tentative and limited information is presently available.

1. Does the teachers' style of teaching change as a result of their participation in the project? This was one of the first questions to which major attention was given in the evaluation. The most important outcome of the project would be changes in what children and teachers do in the classroom. Since the project operates on a multiplier principle to reach large numbers of teachers, the evaluation of classroom changes had to be conducted in the classrooms of those teachers who were being taught by other teachers if the true impact of the project was to be assessed. For

this reason an evaluation of change in teaching style was conducted in the classes of teachers who were randomly selected from among the approximately 150 teachers who were members of ESS or SAPA classes in the three original districts in the project.

Twenty-eight teachers were selected randomly as a group from which pre-test data could be acquired. A different 28 were selected randomly from the 150 teachers as the source of post-test data. In Campbell-Stanley notation this could be represented as follows:

R O X
R X O

This quasi-experimental design provides pre and post data without introducing the possibility of a testing effect and a pretest-treatment interaction effect as influences on the posttest data.

History and maturation, of course, are still threats to internal validity but are judged to be less serious problems than the former two threats to internal validity.

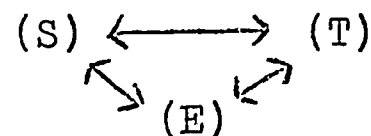
Assessment of changes in teaching style was accomplished through observation of teaching and the use of the Teaching Strategies Observation Differential (TSOD).⁴ This instrument provides an overall rating of the style of teaching employed by a teacher, on a continuum on which the extreme scores are 1 and 8. The extremes, termed expository-direct and inductive-indirect respectively,

⁴Anderson, Ronald D., Joseph A. Struthers, and Helen H. James, "Development of a Verbal and Non-Verbal Observation Instrument," a paper presented at the annual convention of the American Educational Research Association, Minneapolis, Minnesota, March 3, 1970.

are represented by the following diagrams

$(S) \leftrightarrow (T) \leftrightarrow (E)$

expository-direct



indirective-indirect

S represents student, T represents teacher, and E represents the classroom environment including the learning materials employed and the observable science phenomena under study. In the expository-direct style, the teacher acts as interpreter of natural phenomena for the children and is the "filter" through which all information is dispensed. In the other style, children interact directly with science materials and formulate their own conclusions to student generated questions; the teacher's role is largely that of facilitator and supplier of materials.

Since elementary science programs such as ESS, SAPA, and SCIS are focused upon student use of materials and student inquiry, the inductive-indirect mode represents the pole toward which the inservice classes were aimed. A one-tailed test of change in style for the pre and post groups was planned because of this anticipated direction of change.

Because a teacher's style of teaching would be influenced by the subject matter being studied and the materials used, all teachers were provided with the same materials for use during the class scheduled for acquiring observations of teaching. A small unit on earthworms was written which included various suggestions from which the teacher could make her own selections for that day. All teachers were supplied with the same materials, including

earthworms, in sufficient quantities for all children to be working with them. The written material provided for the teacher contained suggestions of uses of the materials that ranged from expository-direct to inductive-indirect.

A 20-30 minute segment of teaching was recorded with a portable video tape recorder as a pre-test in September prior to the inservice classes for the teachers. In January, after completion of the inservice classes, a similar sample of teaching was recorded as a post-test for the other group of randomly selected teachers. By recording the samples of teaching and having both the pre- and post-measures rated at a later date by raters who did not know to which group each teacher belonged, possible rater bias was eliminated.

The rating of the samples was done by a group of four raters, with two raters rating each sample. The raters followed a rotating pattern which resulted in each of the six possible combinations of two raters rating approximately equal number of samples. The Hoyt inter-rater reliability⁵ ranged from .89 to .97 with an average inter-rater reliability of .94.

The results of the ratings are given below:

⁵Winer, B. J. Statistical Procedures in Experimental Design (New York: McGraw-Hill), 1962, pp. 126-128.

	<u>pre</u>	<u>post</u>
mean	4.98	5.64
standard deviation	1.06	.89
n	26	.28

This gain of approximately $2/3$ of a standard deviation is significant at the .01 level with a one tailed test. It is concluded that the one semester inservice course produced a change in the teacher's style of teaching science.

2. To what extent do the teachers actually use the new science materials? Even though the teacher's style of teaching changes in the desired direction does not insure that they actually use the new science program. The managerial problems that accompany a program in which the major student activity is individual or small group work with "hardware," rather than reading and recitation as an entire class, are sufficient to be a significant deterrent to many teachers' use of the program. At this writing only limited "hard data" is available to use in ascertaining the extent to which the materials are in use. A follow-up survey which will provide such information for teachers who completed the inservice course over one year ago is now in the planning stage.

Appendix A contains a thirty item Likert type questionnaire and the responses of 413 teachers who were attending the last session of the inservice classes held during the second year of the project. In the sections entitled "the elementary school

science program" and "your classroom" are several items that give hints about what a teacher can be expected to do once she finishes the inservice program. These responses lead the writers to conclude that most of the teachers will continue using the new materials regularly in the future if the acquisition of materials and equipment is not a problem. The item which was expected to give the most direct information on this question, number 23, is not too informative because it asks about extensive use and during this time many teachers were still having difficulty obtaining some of the materials as indicated in number 30. A more complete answer to the question must await the follow-up.

3. What is the major constraint limiting the full implementation of the new elementary science programs? Conversations with project staff members, school administrators and teachers indicates clearly that the major constraint is the quantity of equipment and materials needed. The extensive use of materials and equipment by individual children is both the major strength and weakness of programs such as ESS, SAPA, and SCIS. Although the cost of the materials is certainly a factor, money alone is not the solution. The logistics of having the needed materials available for the teacher at the proper time is an enormous task. It would be difficult to overstate the importance of attacking this problem in any effort to implement a program such as ESS, SAPA, or SCIS. Based on the Project evaluation the following recommendations are offered:

- a. Inservice classes should not be held unless adequate supplies of materials are available to enable all participating teachers to use the new program with their students.
- b. The ordering of all equipment should be completed as early as possible.
- c. Each district must establish a system of distribution and determine which supply problems are to be handled by the individual schools and which are to be handled by the central administration.
- d. An orientation session on equipment and accompanying problems should be provided for principals. This can be part of the informational sessions on the new science programs which should be provided for administrators.
- e. Storage space and shelves must be provided in each school.
- f. A system of inventorying, check-out, and reordering must be established.
- g. It is often advantageous for one teacher to have major responsibility for any centrally maintained equipment in a school and for the ordering and distribution of expendable materials.
- h. It is often feasible to appoint student associates (probably two or more 5th and 6th graders) for a school to assist the teachers and principal.

- i. A petty cash fund should be available for teachers to draw upon for inexpensive items that are needed on short notice.

4. Were the principals of the participating schools optimally involved? Visits were made to the principals of representative schools for the purpose of acquiring their opinions of the new science programs and the efforts being made to implement them, as well as to ascertain the extent of their involvement in these efforts and their support of them. Principals were often only marginally involved if specific efforts had not been made to get them involved. The principal's central role in solving the equipment problems mentioned above is but one illustration of the importance of having the support of a knowledgeable principal.

5. Do the districts continue the implementation work on their own? The Colorado Elementary Science Project operates on the assumption that if an adequate number of teachers are trained to serve as inservice instructors, they have the experience of teaching a class once under supervision, and a sizeable percentage of teachers in the district have a successful experience with the new program during their initial exposure to it, the district will be willing and able to continue the implementation on their own. A key measure of the success of the project is the extent to which the effort is continued. A systematic assessment of the degree to which this has been done and the reasons for action or lack of

action is yet to be accomplished. Informal communication with the districts involved, however, indicates that several districts are establishing extensive programs for this purpose.

6. Is University credit justifiable for the three semester hour course taught by other teachers? This question has been raised on several occasions by the University Administration. In many ways the answer is a matter of value judgements; it is difficult to answer in any other way than to examine the means of quality control employed. The three main factors upon which quality control depends are: (1) selection, (2) extensive preparation, and (3) supervision of the teachers who serve as instructors of fellow teachers.

The teachers who enter the initial phases of the program are selected by the participating districts. Additional selection is done by the CESP staff. For example, during the first year of the project, approximately one-third of the teachers who entered the program were selected as instructors. The preparation for teaching other teachers includes one full year of using the new science program with the children in their own class while concurrently enrolled in inservice classes totaling approximately 5 semester hours. This is followed by a two-week full time session in the summer that is designed specifically to prepare them to teach other teachers. The supervision is provided by a member of the CESP who devotes full time to the supervision of the classes being taught by these teachers.

The credit question becomes more involved when related to the objective of having each district continue its implementation efforts on its own; under these conditions the supervision discussed above is not present. It is possible for one of the instructors who has been trained through the project to teach the inservice class for credit under the University's Extension Division independent of the CESP if he has a master's degree and a substantial number of hours in science. Since only about 15% of these elementary teachers have master's degrees, further implementation efforts by the district are greatly curtailed if credit is important. Since credit is an important incentive (and for other reasons), a new approach is being employed this year. Teams consisting of a secondary science teacher who has a master's degree and an elementary teacher are being prepared as instructors for the fall of 1970. This team should meet the formal University requirements and increase the possibilities of continued implementation efforts by the local districts after their participation in the Colorado Elementary Science Project.

APPENDIX A

The items below are given as they appeared on an anonymous questionnaire administered to 413 participants in the final phase of the second year of the CESP. The meaning of the symbols is as follows: SA = strongly agree, A = agree, ? = undecided, D = disagree, and SD = strongly disagree. The numerical values given are the percentage of persons checking each response. The difference between the total of the five percentages for each item and 100% is the percentage who did not respond to the item. The percentage of nonresponse varied from .7% to 2.1%.

The elementary school science program

(This section pertains to the ESS, AAAS, or SCIS program, whichever it is you are using.)

	<u>SA</u>	<u>A</u>	<u>?</u>	<u>D</u>	<u>SD</u>
1. This elementary school science program will better prepare pupils for junior high school.	28.3	54.0	13.6	1.9	.7
2. In this science program too much time is spent "messaging around."	4.4	13.3	11.1	50.6	18.6
3. The source of answers to questions is too often the laboratory rather than the teacher.	8.2	19.6	14.5	37.0	18.4
4. The materials are realistic for use by all children.	30.5	45.5	8.2	11.8	2.4
5. The materials are realistic for use by all teachers.	21.0	45.0	12.3	17.2	3.6
6. The daily preparation required to use those materials is reasonable.	17.0	55.4	10.6	12.1	3.6

	<u>SA</u>	<u>A</u>	<u>E</u>	<u>D</u>	<u>SD</u>
7. The results of the program justify the effort required in their use.	26.2	47.2	20.1	4.4	1.4
8. I can recommend the materials to my colleagues.	28.6	53.3	9.9	5.6	1.4

The inservice education program

9. Too much time was given to demonstration teaching.	7.5	14.5	8.2	48.9	20.1
10. Too much time was spent by the instructors observing my classroom teaching.	1.4	.7	6.0	43.3	47.7
11. Too much time was spend working through the lab activities of the elementary school science program.	4.8	7.8	13.1	47.5	25.2
12. More time should be spent presenting science background.	6.8	22.3	16.7	37.3	15.5
13. More time should be spent on the specific activities which will be used in our own classes.	17.9	38.3	14.0	23.2	5.8
14. Too much time was spent telling us what constitutes good science teaching.	3.2	6.5	8.7	53.3	26.9
15. Participants should have been instructed in groups divided according to the grade level they teach.	18.4	25.4	13.6	31.5	9.7
16. More attention should have been given to continuity of the materials in the elementary school science program.	12.6	34.9	19.8	28.1	2.9
17. The instructors were competent and gave us sufficient personal attention.	32.7	43.8	10.6	8.7	3.2

	<u>SA</u>	<u>A</u>	<u>?</u>	<u>D</u>	<u>SD</u>
18. The films were of little educational value.	7.0	13.1	9.7	47.0	22.0
19. The principal should determine the science program (ESS, AAAS, SCIS) used in his building.	1.2	3.4	9.9	33.9	50.4
20. The consultant or supervisor should select participants for inservice programs such as this.	3.2	10.6	15.0	33.4	37.0
21. The science supervisor or consultant should have a greater control than principals on the strategies used in teaching science.	12.6	42.1	21.8	11.6	9.9

22.

Your Classroom

22. I am comfortable using only those pupil activities which we worked through in the inservice education classes.	1.2	9.9	9.4	51.1	26.0
23. I have used the materials of the elementary school science program extensively in my classroom in recent weeks.	14.8	32.2	13.8	29.5	7.5
24. The children accepted the new materials readily.	40.9	40.7	12.6	2.7	1.2
25. The concepts were too difficult for the children to assimilate.	2.2	5.1	13.8	47.7	29.5
26. It was possible to evaluate the progress of the students.	11.4	40.0	27.6	16.0	3.2
27. I feel that it is important to be able to evaluate the children's progress.	29.1	46.7	12.6	8.5	2.2

	<u>SA</u>	<u>A</u>	<u>?</u>	<u>D</u>	<u>SD</u>
28. I now feel more confident of my abilities to teach science than I did at the beginning of the project.	26.6	45.8	13.6	9.0	4.4
29. My principal has encouraged and supported my endeavors with this program.	29.1	37.8	19.4	6.3	5.3
30. I have had difficulty in obtaining the materials needed in my science teaching.	23.5	23.5	9.7	30.5	10.6